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**DETAILED DESIGN REPORT
FOR WELLS W23, W420 AND W421
TREATMENT SYSTEM**

Prepared For:

**REILLY INDUSTRIES, INC.
1500 South Tibbs Ave.
Indianapolis, IN 46241**

Prepared By:

**REMEDIATION TECHNOLOGIES, INC.
3040 William Pitt Way
Pittsburgh, PA 15238**



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April 24, 1990

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1.0 INTRODUCTION

Reilly Industries, Inc. (Reilly) contracted with Remediation Technologies, Inc. (ReTeC) of Pittsburgh, Pennsylvania, to perform an engineering evaluation of alternative treatment systems for pumped groundwaters at its former wood treating and coal tar refining site located in St. Louis Park, Minnesota, which is a Superfund site. A Remedial Action Plan (RAP) embodied within a Consent Decree among Reilly, the City of St. Louis Park (City), the Minnesota Pollution Control Agency (MPCA), the United States Environmental Protection Agency (U.S. EPA) provides specific requirements for remedial action of site groundwaters.

To comply with the provisions of the RAP in terms of achieving groundwater treatment objectives, ReTeC, using historic groundwater quality data, performed an engineering screening evaluation with biological fluidized bed, ozone/UV, hydrogen peroxide/UV, and activated carbon treatment considered as potential options based on technical feasibility. In terms of both economical (i.e., capital and O&M costs) and technical considerations, activated carbon treatment offered the best alternative.

On this basis, plus the fact that activated carbon treatment is a proven and accepted technology, ReTeC performed treatability testing to provide site-specific information related to the technical and economic issues associated with the treatment of the pumped groundwaters via activated carbon treatment. Technical issues related to: (i) the extent to which chemicals-of-interest are removed by the treatment system, (ii) potential operational issues associated with extended treatment, and (iii) the need, if any, for additional controls (i.e., pH control, iron removal, filtration). Economic issues related to engineering design optimization of the treatment system in terms of associated capital and O&M costs. Such information included: (i) representative carbon exhaustion rates, (ii) quantifying required Empty Bed Contact Times, (iii) determining the need for additional controls, and (iv) establishing proper hydraulic loading rates.

Based upon the information developed during treatability testing, it was substantiated that a treatment system comprised of pretreatment (i.e., potassium permanganate chemical oxidation and sand filtration to remove associated iron and

manganese) followed by activated carbon column treatment represents both a technically feasible and economically efficient solution for the St. Louis Park site groundwaters.

An engineering report which provided a detailed conceptual design was issued in conjunction with the Treatability Study Report as part of the Plan for Discontinuing Sanitary Discharges at the Reilly Tar and Chemical Corporation N.P.L. Site (Plan). This Plan was issued on March 23, 1990 to the U.S. EPA and the MPCA for final approval. the following document is a detailed design package for the treatment process with regard to equipment associated with that process. The battery limits for this design package are defined as being the treatment process with regard to the following:

- detailed specifications,
- utility requirements,
- space requirements,
- interconnecting piping,
- general arrangement, and
- system interface.

This detailed design package specifically excludes items which are not considered ReTeC's area of expertise (i.e., building design, civil engineering, electrical engineering, etc.)

The treatment system as defined in the plan requires the following:

- a 1200 foot connecting pipe to be installed between the locations of wells W23 and W420/W421;
- a single treatment system to be located at the W420/W421 location;
- the primary components of the treatment system include:
 - a chemical feed system to add potassium permanganate (KMnO_4) to the pumped groundwater flow,
 - an in-line static mixer to achieve mixing of the potassium permanganate and the pumped groundwater,

- a DynaSand model DSF38 continuous backwashing type sand filter, and
- two (2) five-thousand pound (5,000 lb.) activated carbon columns operating in-series.

The purpose of the potassium permanganate addition is to chemically oxidize reduced iron and manganese species present in the groundwater. This will result in precipitation of the iron and manganese as hydroxides with removal from the groundwaters achieved via sand filtration. The coal-tar related organics (e.g., phenolics and polynuclear aromatic hydrocarbons) will be removed via activated carbon column adsorption. Effluent from the treatment system will meet or exceed all targeted National Pollution Discharge Elimination System (NPDES) criteria. This treated effluent discharge will be routed from the site to Minnehaha Creek via the South Oak Pond storm drainage system. Sand filter backwash water will be discharged to the Minneapolis/St. Paul Metropolitan sanitary sewer system. The total design flowrate for this treatment system is 140 gpm.

The anticipated schedule for treated groundwater discharge into Minnehaha Creek is September, 1990. Thus, process design, procurement and construction must be completed by third quarter 1990.

Specific areas related to the detailed design of the full-scale system are addressed in the following sections. Section 2.0 provides background information associated with the project and the site. Section 3.0 provides the detailed design specifications used as a basis for design of the full-scale system. Associated drawings are located in Appendix A.

2.0 BACKGROUND

This section provides background information related to: (i) site conditions, (ii) preliminary engineering evaluation, (iii) treatability testing, (iv) detailed conceptual design, and (v) the schedule of compliance events as presented in the Plan.

2.1 SITE CONDITIONS

In accordance with various remedial action requirements for its former wood treating and coal tar refining plant site located in St. Louis Park, Minnesota, Reilly installed a series of five source and gradient control wells in 1987. Relevant characteristics of the wells, designated as W23, W105, W420, W421, and W422, are summarized in Table 2-1.

Installation of the wells was specified under the terms of RAP embodied in a Consent Decree between Reilly, the City, the MPCA and the U.S. EPA. These wells, operated by the City, currently discharge to sanitary sewers. As part of a separate arrangement between Reilly and the City that is part of the Consent Decree, Reilly must, by September 1990, provide treatment to permit discharge to storm sewers. These waters will ultimately discharge into Minnehaha Creek, and as such, will require an NPDES discharge permit. The RAP requires that the MPCA draft the necessary NPDES permit using the anticipated NPDES limits given in Table 2-2. At this time, it appears that W105 will not require treatment since its discharge meets both the cessation criteria established by the RAP and the anticipated NPDES limits given in Table 2-2 [1]. Reilly does not intend to pursue treatment of W422 at the present time as this will be addressed by the City in conjunction with the City's operation and discharge of the adjacent St. Peter aquifer source control well W410. Therefore, the engineering evaluation was limited to wells W23, W420 & W421. As illustrated in Figure 2-1, well W23 is located on Louisiana Avenue in a pump house along the edge of an open park. Wells W420 & W421 are located in a pump house located in a light industrial area, approximately 1200 feet south of well W23, at the intersection of Louisiana Avenue and West Lake Street.

TABLE 2-1

**SUMMARY OF SOURCE AND GRADIENT
CONTROL WELL CHARACTERISTICS**

CHARACTERISTICS	W23	W105	W420 [c]	W421 [c]	W422
AQUIFER PUMPED [a]	Prairie du Chein/ Jordan	Ironton/ Gainesville	Drift	Platteville	Drift
RAP REQUIRED PUMPING RATE (gpm)	50	25	40	25	50
DESIGN PUMPING RATE (gpm)	60	NA	50	30	NA
START UP DATE	11/5/87	11/5/87	1/11/88	1/11/88	1/11/88
TOTAL PAH CONC. (ug/l) [b]	190	2.4	3,800	840	56
PHENOLICS (4AAP) (ug/l) [b]	10	< 10	330	< 50	10

NOTES:

[a] - The Drift is the surficial aquifer and is connected hydraulically to the underlying Platteville. The Ironton/Gainesville and Prairie du Chein/Jordan are deep, confined bedrock aquifers.

[b] - Averages based on available sample results through October 1988.

[c] - These wells are located next to each other and share a common discharge line to the sewer.

< - Designates below limit of detection.

NA - Not Applicable.

TABLE 2-2**ANTICIPATED NPDES DISCHARGE REQUIREMENTS**

PARAMETER	DAILY MAXIMUM CONCENTRATION	30-DAY AVERAGE CONCENTRATION^[b]
Total Potentially Carcinogenic PAHs ($\mu\text{g/L}$) ^[a]	NA	0.31 (0.07) ^[c]
Total Other PAHs ($\mu\text{g/L}$) ^[a]	34	17
Phenanthrene ($\mu\text{g/L}$)	2	1
Phenolics (4-AAP) ($\mu\text{g/L}$)	NA	10

NOTES:

NA - Not Applicable

[a] - See Table 2-3 for list of respective individual PAHs.

[b] - Yearly quarterly monitoring may be used in place of the 30-day average.

[c] - Per MPCA comments to draft Engineering Report on December 19, 1989 letter.

FIGURE 2-1



NON-RESPONSIVE

NON-RESPONSIVE

TABLE 2-3

CHEMICALS-OF-INTEREST WITH RESPECTIVE VALUES FOR W23, W420 AND W421

PARAMETER	TARGET NPDES DISCHARGE CONCENTRATIONS			PRAIRIE DU CHIEN/JORDAN W23 SCW DISCHARGE				DRIFT W420 SCW DISCHARGE				PLATTEVILLE W421 SCW DISCHARGE			
POTENTIALLY CARCINOGENIC (P.C.) PAH (ug/L)	DAILY MAX. 30 DAY AVG. [a]			#	AVG.	L95%	U95%	#	AVG.	L95%	U95%	#	AVG.	L95%	U95%
Quinoline				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
Benzo(a)anthracene				1	0.235	NA*	NA*	0	ND	ND	ND	0	ND	ND	ND
Chrysene				1	0.283	NA*	NA*	0	ND	ND	ND	0	ND	ND	ND
Benzo(b)anthracene				1	0.024	NA*	NA*	0	ND	ND	ND	0	ND	ND	ND
Benzo(a)pyrene				1	0.028	NA*	NA*	0	ND	ND	ND	0	ND	ND	ND
Indeno(1,2,3-cd)pyrene				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
Dibenz(a,h)anthracene				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
Benzo(ghi)perylene				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
Total Detectable P.C. PAH	NA	0.31 (0.07)[b]		1	0.570	NA*	NA*	0	ND	ND	ND	0	ND	ND	ND
OTHER PAH (ug/L)															
2,3-Benzofuran				4	6.5	0.0	13.6	7	41.8	19.8	63.8	4	2.6	0.3	4.8
2,3-Dihydroindene				9	22.5	10.9	34.2	8	127.3	89.4	165.1	8	128.0	100.0	156.0
Indene				9	18.3	0.1	36.5	8	203.6	113.2	294.0	8	86.0	64.0	108.0
Naphthalene				10	66.1	23.2	109.0	9	1661.8	1034.6	2288.9	9	500.4	410.2	590.7
Benzo(b)thiophene				9	11.7	3.1	20.3	7	112.3	67.8	156.8	7	63.6	50.1	77.1
Indole				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
2-Methylnaphthalene				9	14.6	0.0	29.6	7	87.4	37.6	137.3	3	1.9	0.0	3.9
1-Methylnaphthalene				9	20.4	5.9	35.0	7	84.9	50.9	118.8	7	27.3	19.6	35.0
Biphenyl				9	6.2	2.4	9.9	6	18.6	11.7	25.3	3	3.3	1.3	5.4
Acenaphthylene				10	5.1	2.2	7.9	1	61.7	NA*	NA*	1	44.2	NA*	NA*
Acenaphthene				10	20.7	13.1	28.3	8	73.8	51.6	95.9	7	18.1	12.7	23.4
Dibenzofuran				9	10.5	4.3	16.6	7	27.0	18.4	35.6	3	2.9	0.3	5.5
Fluorene				10	14.4	9.6	19.1	8	21.7	14.0	29.4	5	3.7	2.2	5.2
Dibenzothiophene				6	1.4	1.1	1.7	2	1.8	0.0	5.4	1	100.0	NA*	NA*
Phenanthrene	2.0	1.0		10	16.8	10.5	23.0	6	9.8	4.8	14.8	3	1.3	1.1	1.6
Anthracene				10	2.2	1.5	2.9	0	ND	ND	ND	0	ND	ND	ND
Acridine				0	ND	ND	ND	0	ND	ND	ND	2	1.1	0.6	1.5
Carbazole				8	2.9	1.6	4.3	7	47.4	37.5	57.4	7	16.9	12.1	21.6
Fluoranthene				10	5.4	4.1	6.7	0	ND	ND	ND	0	ND	ND	ND
Pyrene				10	4.4	3.5	5.3	0	ND	ND	ND	0	ND	ND	ND
Benzo(e)pyrene				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
Perylene				0	ND	ND	ND	0	ND	ND	ND	0	ND	ND	ND
Total Detectable Other PAH	34.0	17.0		10	234.6	103.9	365.3	9	2378.3	1480.6	3276.1	9	811.1	661.3	960.8
OTHER PARAMETERS (mg/l)															
Oil & Grease				1	5	NA*	NA*	1	10	NA*	NA*	1	7	NA*	NA*
Phenolics (4-AAP)	NA	0.010		1	0.010	NA*	NA*	8	0.230	0.089	0.370	7	0.037	0.024	0.049
TSS				1	2	NA*	NA*	1	9	NA*	NA*	1	1	NA*	NA*

NOTES: Actual data given in Appendix A

NA* - Not Applicable since parameter was detected in only one sample.

NA - Not Applicable.

ND - Not Detectable.

[a] - Yearly quarterly monitoring may be used in place of the 30 - day average.

[b] - Per MPCA comments to draft Engineering Report in December 19, 1989 letter.

- Number of detectable concentrations used to compute respective statistics.

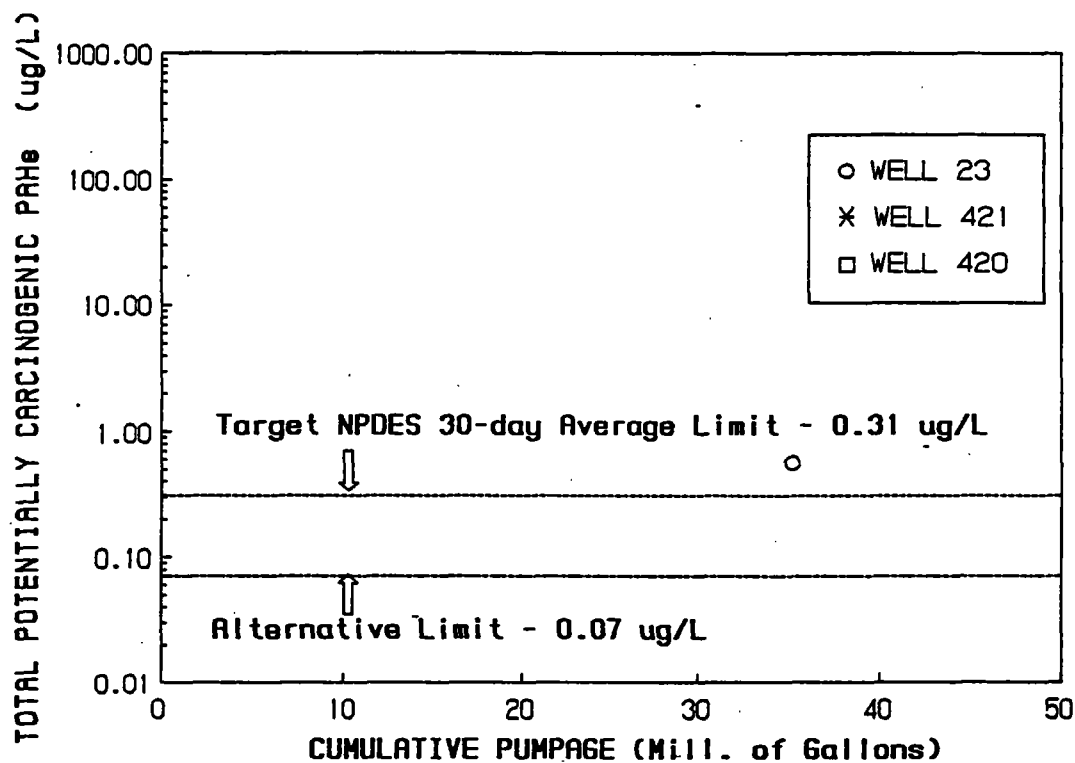
AVG - Average of reported values.

L95% - Lower 95% Confidence Interval Limit.

U95% - Upper 95% Confidence Interval Limit.

FIGURE 2-2

TOTAL POTENTIALLY CARCINOGENIC PAHs
-VS-
CUMULATIVE PUMPAGE



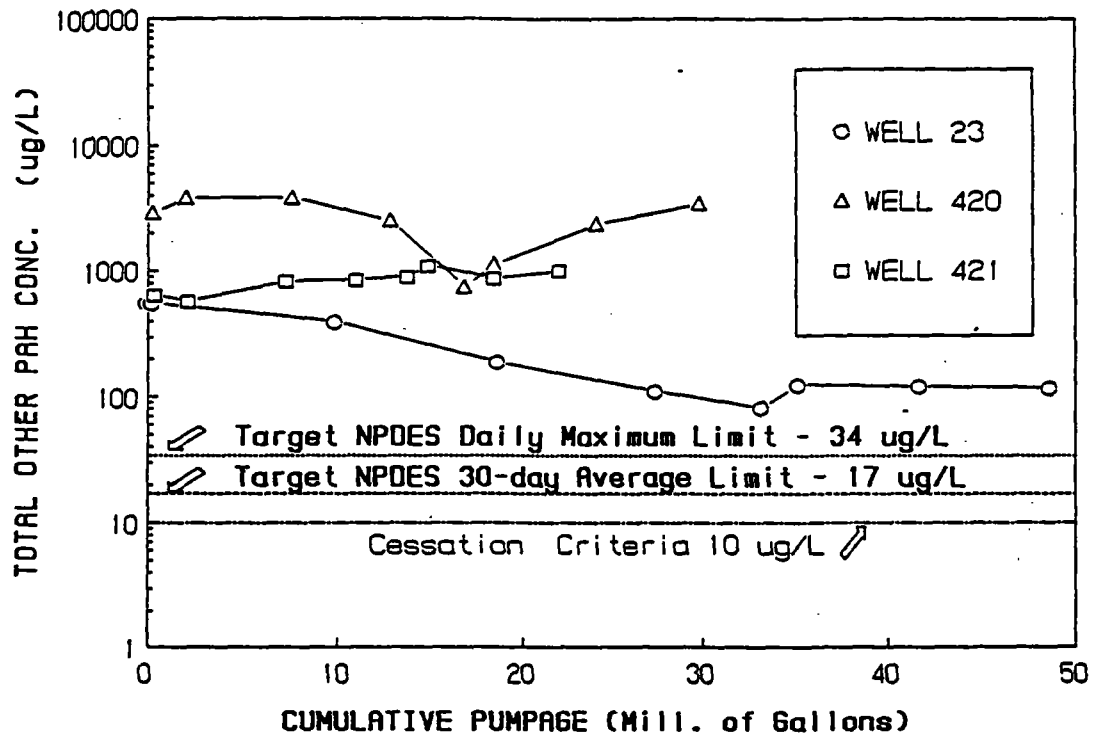
NOTE:

Daily maximum limit is not applicable.

Only one sampling occasion where respective concentrations were measure at detection limits below 1.0 ug/L, all other occasions resulted with non-detectable concentrations.

FIGURE 2-3

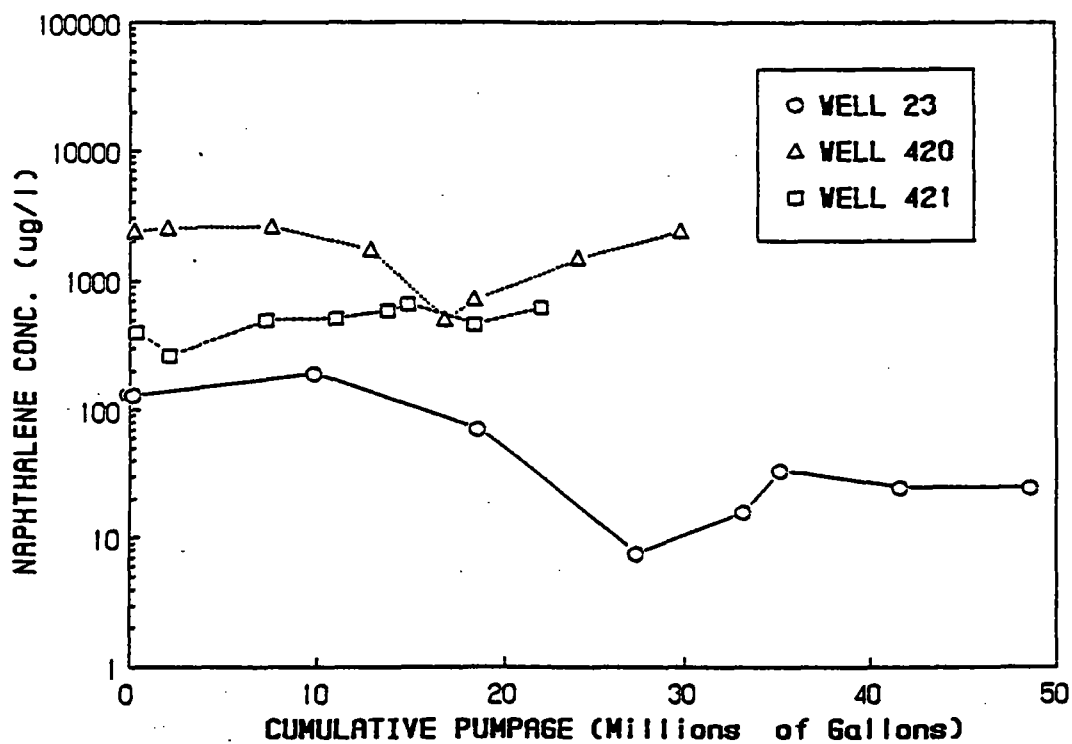
TOTAL OTHER PAHs
-VS-
CUMULATIVE PUMPAGE



NOTE: Only Detectable Concentrations Are Plotted.

FIGURE 2-4

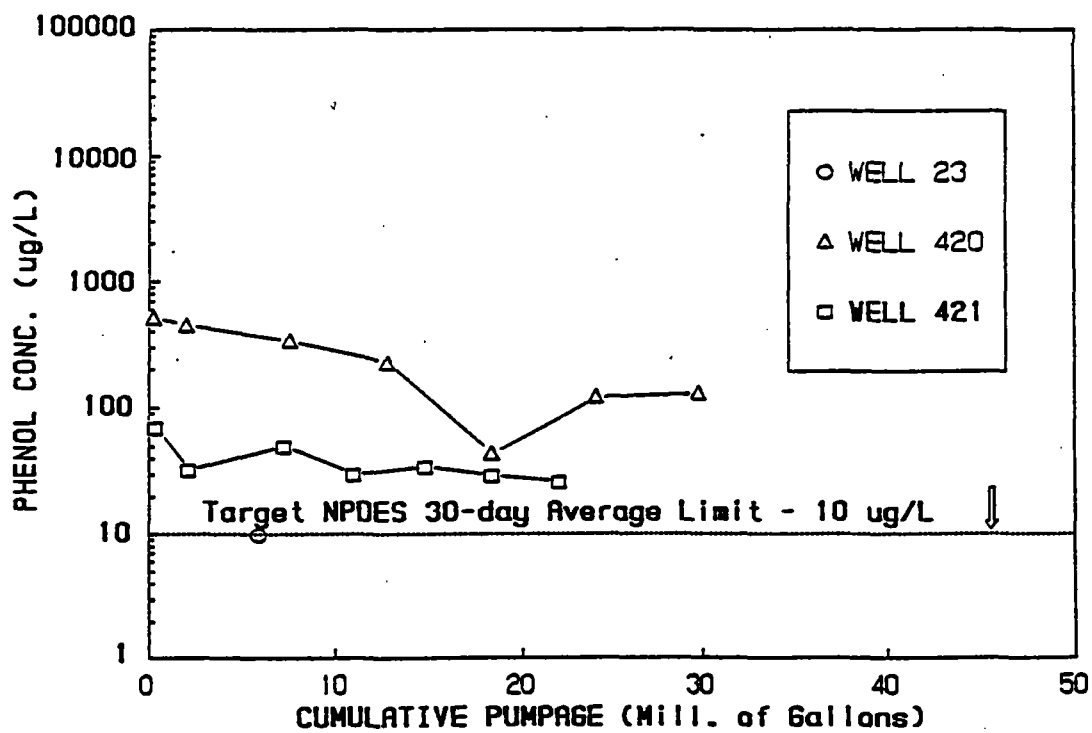
**NAPHTHALENE
-VS-
CUMULATIVE PUMPAGE**



NOTE: For Purposes of NPDES Discharge Monitoring.
Naphthalene is Considered as a Member of the Other
PAHs Grouping. Only Detectable Quantities are Plotted.

FIGURE 2-5

**PHENOLICS
-VS-
CUMULATIVE PUMPAGE**



**NOTE: Daily Maximum Limit Is Not Applicable.
Only Detectable Concentrations Are Plotted.**

Referring to Figure 2-2, potentially carcinogenic PAHs were not detected in the well discharges at method detection limits (i.e., reporting limits) ranging between 10 to 200 $\mu\text{g/L}$; thus, it is not quantifiably known if the anticipated 30-day average target NPDES requirement of 0.31 $\mu\text{g/L}$ is exceeded or not. To measure such low concentrations, a method detection limit of 0.01 $\mu\text{g/L}$ must be achieved. This is analytically difficult to achieve for the site groundwaters in question given the fact that the groundwaters are relatively contaminated in terms of other PAH parameters. As cited in Figure 2-2, based on quantifiable data, the targeted NPDES requirements of 0.07 or 0.31 $\mu\text{g/L}$ were exceeded on only one occasion with Total Potentially Carcinogenic PAHs measured only once at approximately 0.57 $\mu\text{g/L}$. This sampling event corresponded to PAH analysis by HPLC which was able to detect PAHs at lower quantifiable limits than the GC/MS Selective Ion Method (SIM) routinely used by Rocky Mountain Analytical Laboratories (Arvada, Colorado) as part of the routine monitoring specified by the RAP. The HPLC analysis was performed by Keystone Environmental Resources, Inc. (KER) Laboratory (Monroeville, Pennsylvania) as part of ReTeC's treatability studies [3]. The fact that potentially carcinogenic PAHs were not routinely detected using the GC/MS-SIM method is not an important issue since activated carbon treatment will remove these PAHs to levels below 0.01 $\mu\text{g/L}$ detection. As cited in the Plan, carbon exhaustion will be determined by Other PAHs (i.e., naphthalene) and phenolics (4-AAP).

In terms of the other parameters, Figures 2-3 through 2-5 illustrate that all three well discharges require treatment. In terms of Total Other PAH and naphthalene, Figures 2-3 and 2-4 indicate steadily declining concentrations in well W23. It is not certain as to when the discharge quality will drop below 10 $\mu\text{g/L}$, at which point W23 could be shut down after pumping for at least five years as cited in the RAP. Contrary to this, Total Other PAH and phenolic concentrations in wells W420 and W421 have remained steady or increased over time, with no indication that they may decline in the near term. As cited in the Plan, phenolics were monitored twice in W23 with a detectable quantity measured only once, thus no line plot appears in Figure 2-5 with respect to W23.

The data indicate that the full-scale treatment system design should be capable of treating varying influent organic concentrations from all three wells; and should be considered as a permanent (a decade or more) installation.

2.2 PRELIMINARY ENGINEERING EVALUATION

Given the preceding design constraints and historic groundwater quality data, ReTeC performed an engineering screening evaluation with biological fluidized bed, ozone/UV, hydrogen peroxide/UV, and activated carbon treatment considered as potential options based on technical feasibility. This evaluation focused on: (i) combined treatment of W420/W421 with single treatment of W23, and (ii) combined treatment of all three wells at the location of W420/W421. In terms of economic considerations (i.e., capital and O&M costs), activated carbon treatment of all three wells combined was selected as the preferred treatment scheme. Defining a treatment system for the three well discharges combined at the location of wells W420/W421 (shown in Figure 2-1) with a connecting pipe from W23.

2.3 TREATABILITY TESTING

Treatability testing was performed to further evaluate activated carbon column treatment of site groundwaters and provide information to evaluate technical and economic issues. Technical issues related to: (i) the need for iron and manganese removal via a pretreatment process, (ii) the extent to which site chemicals-of-interest are removed by the treatment system, (iii) potential operational issues associated with extended treatment, and (iv) additional control processes (e.g., pH control and backwash tanks). Economic issues related to engineering design optimization of the treatment system in terms of associated capital and O&M costs. Such information included: (i) representative carbon exhaustion rates, (ii) quantifying required Empty Bed Contact Times (EBCT), (iii) quantifying dosages of treatment chemicals if required, and (iv) establishing proper hydraulic loading rates.

2.4 TREATMENT SYSTEM DESCRIPTION

A conceptual schematic diagram of the proposed treatment system is given in Figure 2-6. Figure 2-6 is not intended to serve as a detailed process flow diagram. As shown, pumped groundwaters from wells W23, W420 and W421 will be combined by means of a 1200 foot underground connecting pipe as previously shown in Figure 2-1. This connecting pipe will be buried and run from the W23 location to the W420/W421

location and will require passing underneath a four lane highway. Initial engineering evaluation indicated that this line will be 3-4 inches in diameter with an adequate pumping head already available from the existing groundwater pump at W23. The treatment system will be located in the vicinity of the existing W420/W421 pump house. The system will be operated continuously to maintain hydraulic gradient control.

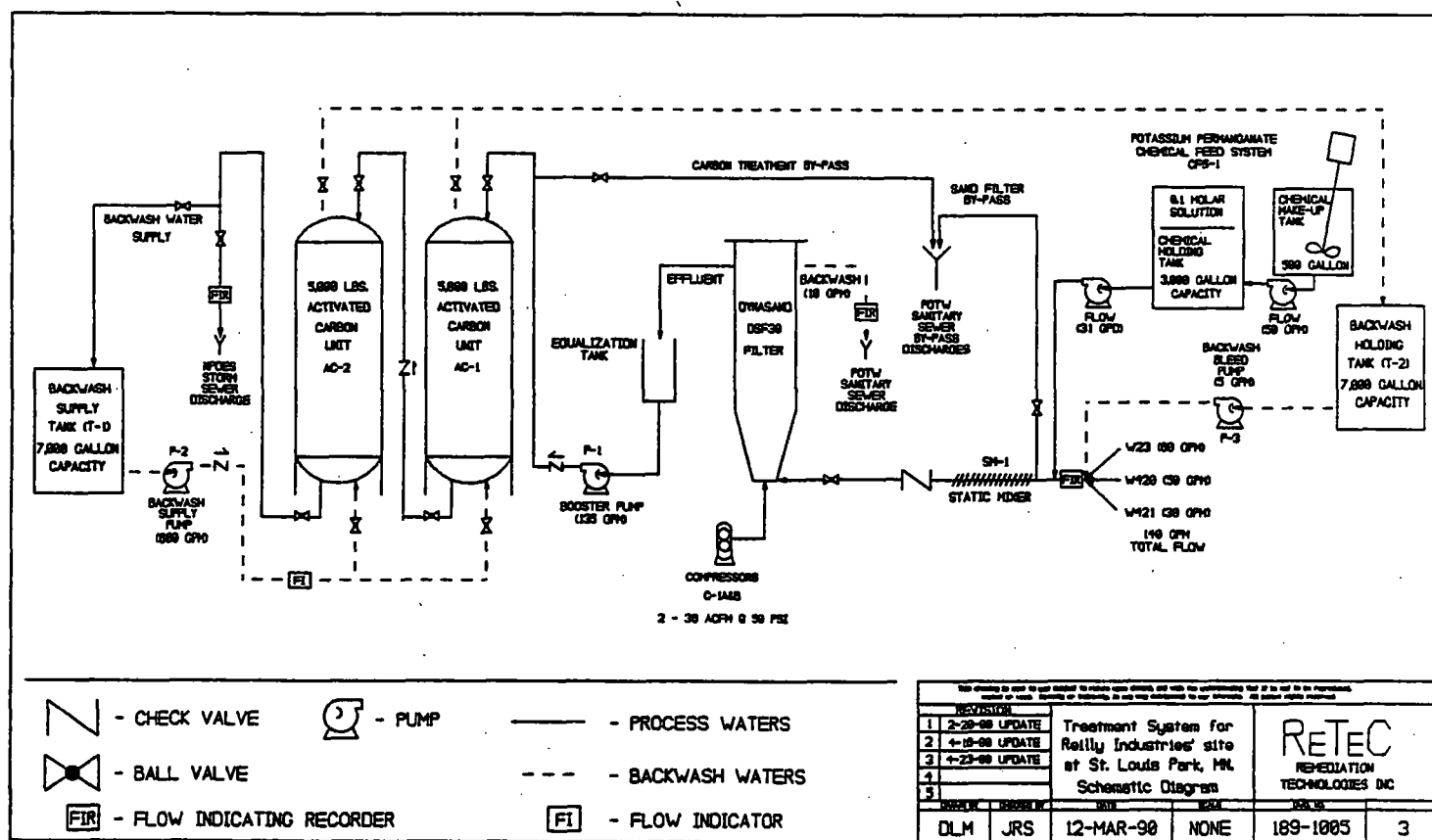
The combined influent from W23, W420 and W421 will pass through an in-line static mixer (SM-1) where potassium permanganate (KMnO_4) will be added via a chemical feed system (CFS-1) at a ratio of 1:1 for iron (Fe) and 2:1 for manganese (Mn). This chemical oxidation step will cause the soluble metals of interest (i.e., Fe and Mn) to precipitate, forming insoluble suspended particulate matter. The flow will then pass on to a continuous backwashing type sand filter where the particulates will be removed via upflow packed bed filtration.

During October 26, 1989, through November 6, 1989, a 40 gpm pilot test of a DynaSand continuous backwash upflow sand filter was performed at the St. Louis Park site treating a flow proportioned volume of wells W420 and W421. Results of this testing support the efficiency of using a DynaSand filter to remove precipitated iron and manganese from the groundwater prior to carbon adsorption. A detailed report of this on-site pilot-scale filtration test is given as Appendix C to the Engineering Evaluation Report included in the Plan.

For the full-scale treatment system, effluent from the DynaSand filter will flow to an equalization tank. Tank contents will be pumped through two downflow, packed bed, activated carbon adsorption columns (AC-1 & AC-2). The activated carbon will remove organic chemicals-of-interest (i.e., phenolics and PAHs) to levels below targeted NPDES discharge requirements. The specific system identified for the St. Louis Park site will consist of two-5,000 lb. carbon units in-series. The system is designed for a process flow rate of 140 gpm and allows for alternating the lead/lag functions of the two filters. The complete system shall be capable of bulk carbon filling, slurry discharge of spent carbon and be backwashable. With regard to backwashing, treated effluent will be stored in a 6,800 gallon capacity backwash water supply tank (T-1) with backwash supply water provided to either carbon unit via a 600 gpm backwash water supply pump (P-2). Backwash water from the carbon system will be directed into a 6,800 gallon capacity backwash holding tank (T-2). This backwash water will be bled back into the treatment

FIGURE 2-6

FULL-SCALE TREATMENT SYSTEM CONCEPTUAL SCHEMATIC



system at a flowrate of approximately 5 gpm via a bleed pump (P-3). Treated effluent from the activated carbon column treatment system will be directed into the South Oak Pond storm drainage system for ultimate disposal in the Minnehaha Creek.

Figure 2-6 also depicts by-pass lines for both the sand filter and the activated carbon system to sanitary sewer discharge. The by-pass will allow gradient control wells W23, W420 and W421 to continue pumping in the event of process failure or equipment maintenance.

2.5 SCHEDULE OF COMPLIANCE EVENTS

Table 2-4 shows the tentative implementation schedule presented in the Plan submitted to the agencies on March 23, 1990. The schedule, as listed, permits for construction to occur within a three-month period and initial treatment discharge to occur in late September 1990.

TABLE 2-4

**TENTATIVE IMPLEMENTATION SCHEDULE FOR
DISCONTINUING SANITARY SEWER DISCHARGES**

<u>ACTIVITY</u>	<u>APPROX. DATE</u>
Submit Plan to U.S. EPA and MPCA	No. 21, 1989*
Submit NPDES Permit Application to MPCA	Dec. 1, 1989*
U.S. EPA/MPCA Comments on Plan	Feb. 22, 1990*
Submit Revised Plan to U.S. EPA and MPCA	March 23, 1990*
U.S. EPA/MPCA Approval of Plan	April 16, 1990
Submit Detailed Design for U.S. EPA, MPCA and City Review	April 20, 1990
U.S. EPA/MPCA/City Comments on Detailed Design	April 30, 1990
Final Detailed Design Drawings and Specifications	May 25, 1990
U.S. EPA/MPCA/City Approval of Detailed Design	June 1, 1990
Issuance of NPDES Permit (allowing 6 months)	June 1, 1990
Complete Bidding Process for Construction	July 1, 1990
Complete Construction of Treatment Plant	Sept. 30, 1990

Note:

* Activity Complete

3.0 DETAILED DESIGN

This section provides the detailed process design and the detailed general arrangement for the equipment along with building requirements.

3.1 MAJOR EQUIPMENT ITEMS

The major pieces of equipment cited in Figure 2-6 are further discussed in Table 3-1. The general specifications of each of the major items are based upon the design basis given in the Engineering Evaluation Report as derived during the treatability study and from respective manufacturers design information. The O&M requirements given relate to KMnO_4 and carbon usages along with electrical utility requirements. Not included with this major equipment list are miscellaneous items such as flow meters, valves, alarms, and operational and NPDES monitoring equipment.

Located in Appendix A is a detailed process and instrumentation diagram which depicts all of the equipment and piping necessary to assemble the full-scale system. Please refer to this drawing number 352-1002 for additional information. Drawing number 352-1001, P&ID legend, is supplied to help interpret any coding and symbols used in the Process and Instrumentation Diagram.

3.2 BUILDING REQUIREMENTS

Drawing numbers 352-1003, General Arrangement—Plan View, and 352-1004, General Arrangement—Elevation located in Appendix A; depict that a building approximately 25 ft. high with an area of 48 ft. x 47 ft. in floor size will be required to house the entire treatment process.

TABLE 3-1

SUMMARY OF THE MAJOR EQUIPMENT AND UTILITY REQUIREMENTS

I.D. NUMBER [a]	DESCRIPTION	GENERAL SPECIFICATION	O&M REQUIREMENTS [b]
<u>PRETREATMENT WITH POTASSIUM PERMANGANATE AND SAND FILTRATION</u>			
T-3	KMnO ₄ Chemical Feed System	3,000 gallon tank with mixer and metering pump.	1,473 pounds KMnO ₄ per year.
SM-1	In Line Static Mixer	145 GPM.	NA
F-1, DSF38	Sand Filter	DynaSand continuous backwashing filter with sand media of 0.9 mm Effective Size and < 1.5 Uniformity Coefficient.	10 gpm reject stream to sanitary sewer (POTW).
C-1A, C-1B	Air Compressor	36 SCFM @ 50 PSIG, 2 Stage, 10 HP, 3 Phase, 230/460 Volt.	1.2 Kilowatt/hr
<u>ACTIVATED CARBON COLUMN TREATMENT</u>			
P-1	Booster Pump	200 GPM @ 58 FT TDH, Centrifugal, 5 HP, 3 Phase, 230/460 Volt.	3.7 Kilowatt/hr
AC-1, AC-2	Carbon Columns	2 - 5,000 lbs. units in series with backwash capability, 7.5' x 11' (diameter x height).	6,200 - 9,200 pounds per year. [c]
P-2	Backwash Supply Pump	650 GPM @ 58 FT TDH, Centrifugal, 15 HP, 3 Phase, 230/460 Volt.	11.2 Kilowatt/hr
T-1	Backwash Supply Tank	6,800 gallon capacity.	NA
T-2	Backwash Holding Tank	6,800 gallon capacity.	NA
T-4	Equalization Tank	3,000 gallon capacity.	NA
P-3	Backwash Bleed Pump	10 GPM @ 58 FT TDH, Centrifugal, 3 HP, 3 Phase, 230/460 Volt.	2.2 Kilowatt/hr

NOTES:

- [a] - Refer to Drawing Number 352-1002.
- [b] - Refers to Chemical, Carbon and Utility Requirements.
- [c] - Taken from Reference 3.
- NA - Not Applicable

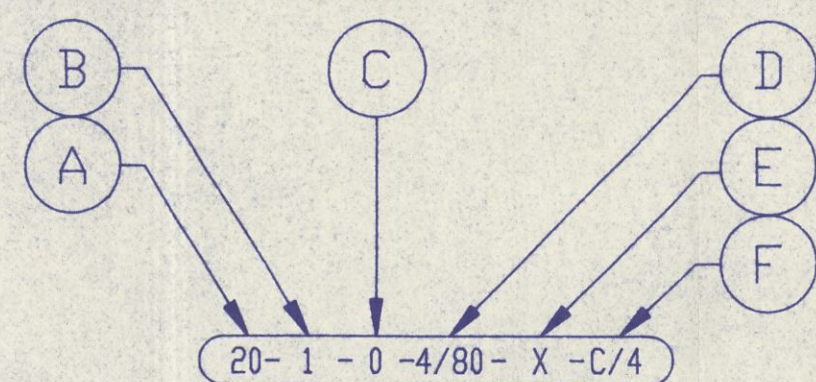
REFERENCES

- [1] City of St. Louis Park, "Annual Monitoring Report for 1988 - Reilly Tar & Chemical Corporation, NPL Site - St. Louis Park, Minnesota," March 15, 1988, (See Page 2).
- [2] Miller, I. and Freund, J.E., "Probability and Statistics for Engineers," Pretice-Hall, Inc., Englewood Cliff, New Jersey, 1965.
- [3] Remediation Technologies, Inc. (Pittsburgh, PA), "Engineering Evaluation Report for Treatment of Pumped Groundwaters at St. Louis Park, Minnesota," Report Prepared for Reilly Industries, Inc., October, 1989.

P & I DIAGRAM SYMBOL LEGEND

LINE TYPE DESIGNATION	INSULATION DESIGNATION	INSTRUMENT LINE DESIGNATION	VALVE SYMBOLS	VALVE ACTUATORS	INSTRUMENT BALLOONS
NEW PIPING	INSULATED PIPING	INSTRUMENT AIR	GATE VALVE	DIAPHRAGM	PANEL MOUNTED INSTRUMENT
NEW EQUIPMENT	TRACED AND INSULATED PIPING	CAPILLARY TUBING	GLOBE VALVE	HYDRAULIC	REAR PANEL MOUNTED INSTRUMENT
EXISTING EQUIPMENT & PIPING	JACKETED PIPING	ELECTRIC LEAD	PLUG VALVE	SOLENOID	LOCALLY MOUNTED INSTRUMENT
	INSULATED EQUIPMENT	HYDRAULIC PIPING	BALL VALVE	PISTON	EXISTING INSTRUMENT
		SOFTWARE	CHECK VALVE	ELECTRIC	INSTR. FURNISHED WITH EQUIPMENT
		ELECTROMAGNETIC OR SONIC	BUTTERFLY VALVE	DOWNSTREAM PRESSURE REGULATOR	NO. OF INSTRUMENTS REQUIRED
			BACKFLOW PREVENTER		DIST. CONTROL DISPLAYED ON CRT
					DIST. CONTROL BLIND FUNCTION
					DIST. CONTROL MANUAL BACKUP
					PROGRAMABLE LOGIC
					DATA LOGGER
					SPECIALTY ITEM

PIPE LINE SPECIFICATION (A-B-C-D-E-F)



A — COMMODITY LIST

- 1 - PROCESS WATER
- 2 - POTABLE (PLANT) WATER
- 3 - CHEMICAL FEED
- 4 - OVERFLOW
- 5 - BACKWASH WATER
- 6 - COMPRESSED AIR
- 7 - CARBON TRANSFER
- 8 - TREATED WATER
- 9 - CHEMICAL TRANSFER

B — LINE NUMBER

SECTION OF PIPE LINES NUMBERED IN SEQUENCE STARTING WITH NUMBER 1.

C — PIPELINE MATERIAL OF CONSTRUCTION

- 0 CARBON STEEL
- 1 CARBON STEEL - LINED
- 2 GALVANIZED CARBON STEEL
- 3 304L STAINLESS STEEL
- 4 316L STAINLESS STEEL
- 5 904 STAINLESS STEEL
- 6 CARPENTER 20
- 7 200 NICKEL
- 8 IRON
- 9 PLASTIC (TO BE SPECIFIED)

D — PIPE SIZE / SCHEDULE

NOMINAL PIPE SIZE / PIPE SCHEDULE

E — INSULATION IDENTIFICATION

- H WATER JACKETED
- Q STEAM JACKETED
- R HOT OIL JACKETED
- S NOT INSULATED
- T ELECTRICALLY TRACED
- W INSULATED FOR HEAT CONSERVATION
- X STEAM TRACED AND INSULATED
- Y INSULATED FOR PERSONNEL PROTECTION
- Z ELECTRICALLY HEATED AND INSULATED LINES (IMPEDANCE)

F — INSULATION - MATERIAL / THICKNESS IN INCHES

- C CALCIUM SILICATE
- F FIBERGLASS
- U USERS CHOICE

INSTRUMENT BALLOON LETTER IDENTIFICATION

1st LETTER	2nd LETTER	3rd LETTER	4th LETTER	LAST LETTER
A ANALYZER	ALARM	ALARM	ALARM	ALARM
B BURNER (FLAME)				
C CONTROL (LOOP)	CONTROLLER	CONTROLLER	CONTROLLER	CONTROLLER
D DENSITY	DIFFERENTIAL *			DRIVE, OPERATOR
E VOLTAGE	ELEMENT			ELEMENT
F FLOW	RATIO *	FLOW	FLOW	
G GAUGE				GLASS
H HAND (MANUAL)		HIGH	HIGH	HIGH
I AMPERES	INDICATOR			INDICATOR
J POWER				MTR PB & LGT
K TIME (COUNT)				
L LEVEL	LEVEL	LOW	LOW	LOW
M MOISTURE				METER
N				
O OPERATIONAL				
P PRESSURE	PRESSURE	PRESSURE		PNEUMATIC
Q SPECIAL	INTEGRATE	INTEGRATE	INTEGRATE	INTEGRATE
R RELIEF	RECORDER	RECORDER	RECORDER	RECORDER
S SPEED, SOLENOID	SAFETY *	SWITCH	SWITCH	SWITCH
T TEMPERATURE	TEMPERATURE	TOTALIZER		TRANSMITTER
U MULTIVARIABLE	MULTIVARIABLE			MULTIVARIABLE
V VIBRATION	VALVE	VALVE	VALVE	VALVE
W WEIGHT				WELL
X				
Y USERS CHOICE				TRANSDUCER
Z POSITION				COMPUTER

SYMBOLS SUCH AS CO₂, D₂, BTU, √, Σ, ETC SHOULD BE SHOWN NEXT TO INSTRUMENT TAG.

FUNCTION ID.	FUNCTION IDENTIFICATION
1st LETTER	FIRST LETTER = MEASURED OR INDICATING VARIABLE
2nd LETTER	* = MODIFIES MEASURED OR INDICATING VARIABLE
LAST LETTER	SUCCESSING LETTERS = READOUT AND/OR FUNCTIONS
SYMBOL	
LOOP NUMBER	THIS NUMBER IS THE SAME AS THE EQUIPMENT NUMBER THAT INSTRUMENT IS ASSOCIATED WITH.

MISCELLANEOUS SYMBOLS

IA INSTRUMENT AIR	PSE RUPTURE DIC. (PRESSURE)	FC FAIL CLOSED
ST, SP, RN, ETC.	PSV VACUUM RELIEF VALVE	FO FAIL OPEN
I INTERLOCK FUNCTION	PSV PRESSURE & VACUUM RELIEF VALVE	FL FAIL LAST
P INSTRUMENT PURGE	RELIEF VALVE	ATO AIR TO OPEN
DIAPHRAGM SEAL		ATC AIR TO CLOSE
EXPANSION JOINT		ST START
PIPE SIZE REDUCTION		SP STOP
FLEX CONNECTOR		RN RUN / INDICATING
XXX VALVE SPECIFICATION NUMBER		
XXX VALVE SIZE		
	TP - TIE POINT	

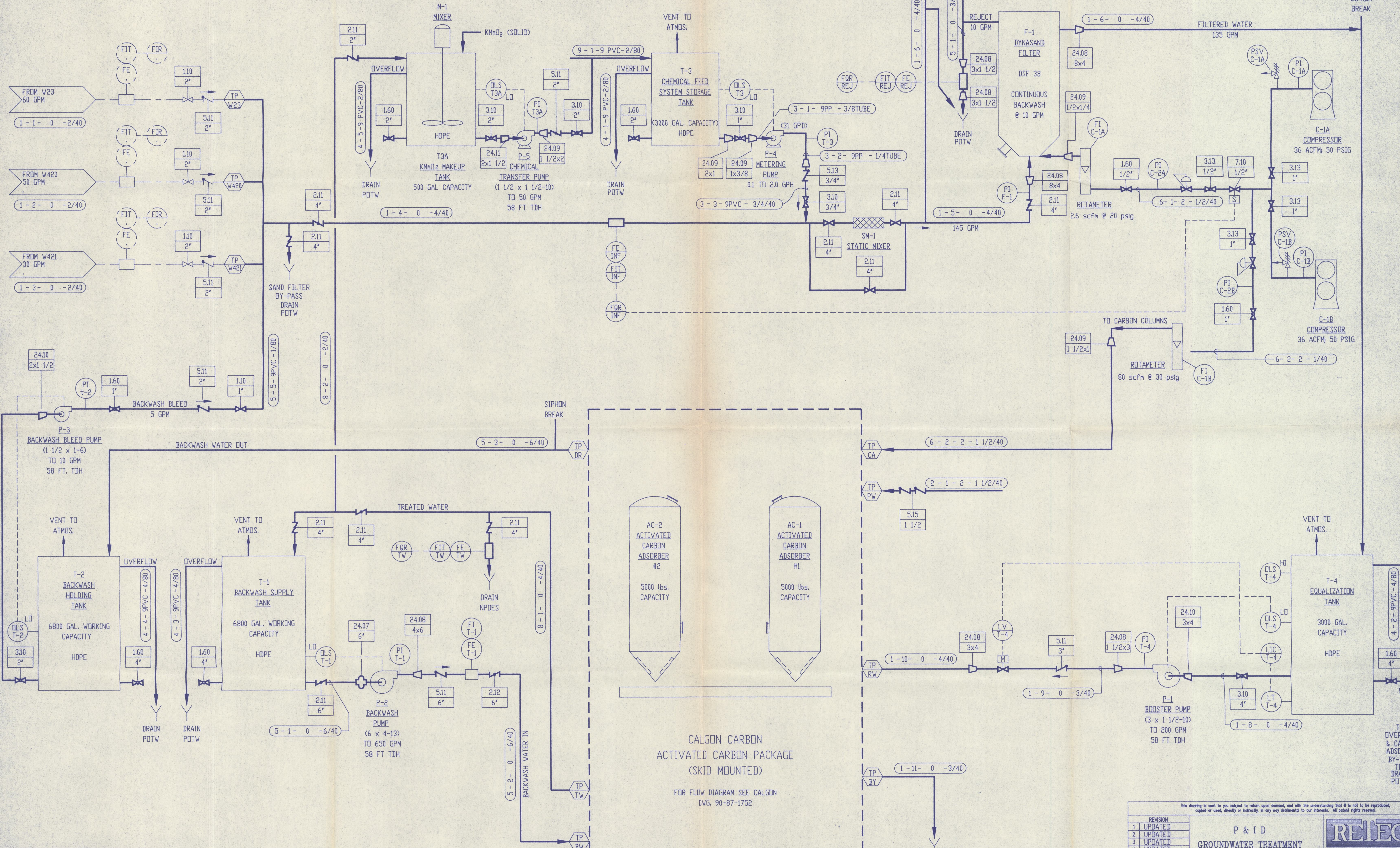
INSTRUMENT LOOP SAMPLES

TRANSMITTED FOR REMOTE INDICATION	REMOTE CONTROL
PT 100 — PI 100 PNEUMATIC	LT 100 — LIC 100 PNEUMATIC
PT 100 — PI 100 ELECTRIC	LT 100 — LIC 100 ELECTRIC I/P
PT 100 — PI 100 DISTRIBUTED CONTROL	LT 100 — LIC 100 DISTRIBUTED CONTROL
LOCAL	LOCAL CONTROL
PI 100 PRESSURE GAUGE	TIC 100 — TV 100
TI 100 THERMOMETER	TE 100 SEPARATE CONTROLLER
ANALYSIS	PCV 100 SELF - ACTING OR SELF - CONTAINED
ORIFICE PLATE WITH TRANSMITTER	SEQUENCE AND/OR OPEN LOOP CONTROL (ON - OFF)
FT 100 FE 100	HS 100 — SV 100
	IA ELECTRIC MANUALLY CONTROLLED
DISTRIBUTED MOTOR CONTROL	OPEN LOOP CONTROL (MANUAL LOADER)
DIS 100 — ST 100 START STOP WITH INDICATION	HIC 100 — HV 100 PNEUMATIC
DT 100 — RN 100 WITH INDICATION ONLY	HIC 100 — HV 100 ELECTRIC

REVISION		P & ID STANDARDS SYMBOL LEGEND SHEET		REMEDIAL TECHNOLOGIES INC	
1	GENERAL REVISION				
2					
3					
4					
5					
DRAWN BY	DATE	CHECKED BY	DATE	SCALE	DRAWING NUMBER
Uleneice	1-22-90			NONE	352-1001
					REV.
					1

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Consultants, Inc.

5145-D001 L.Meneice 1-22-90
PITTSBURGH, PENNSYLVANIA

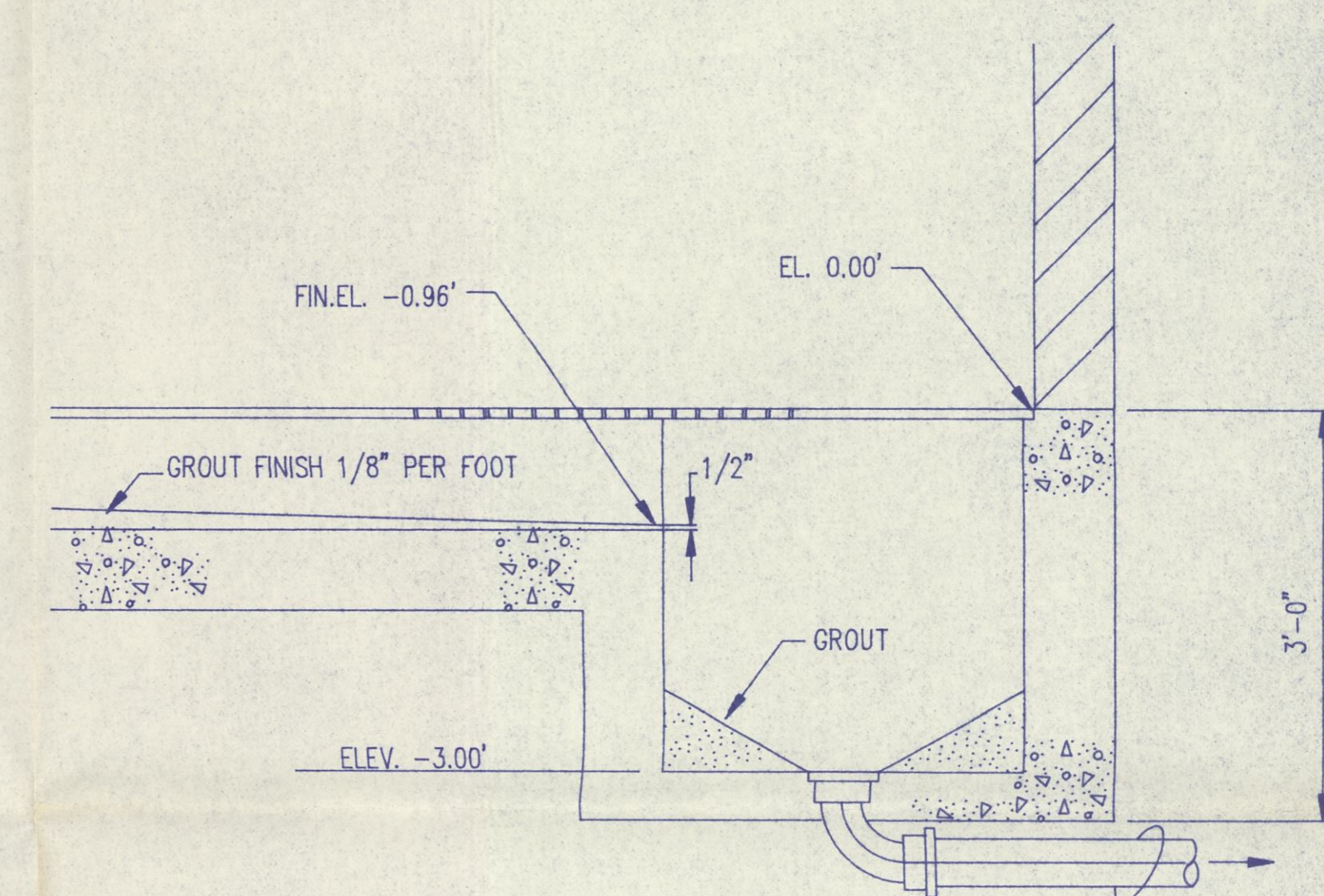
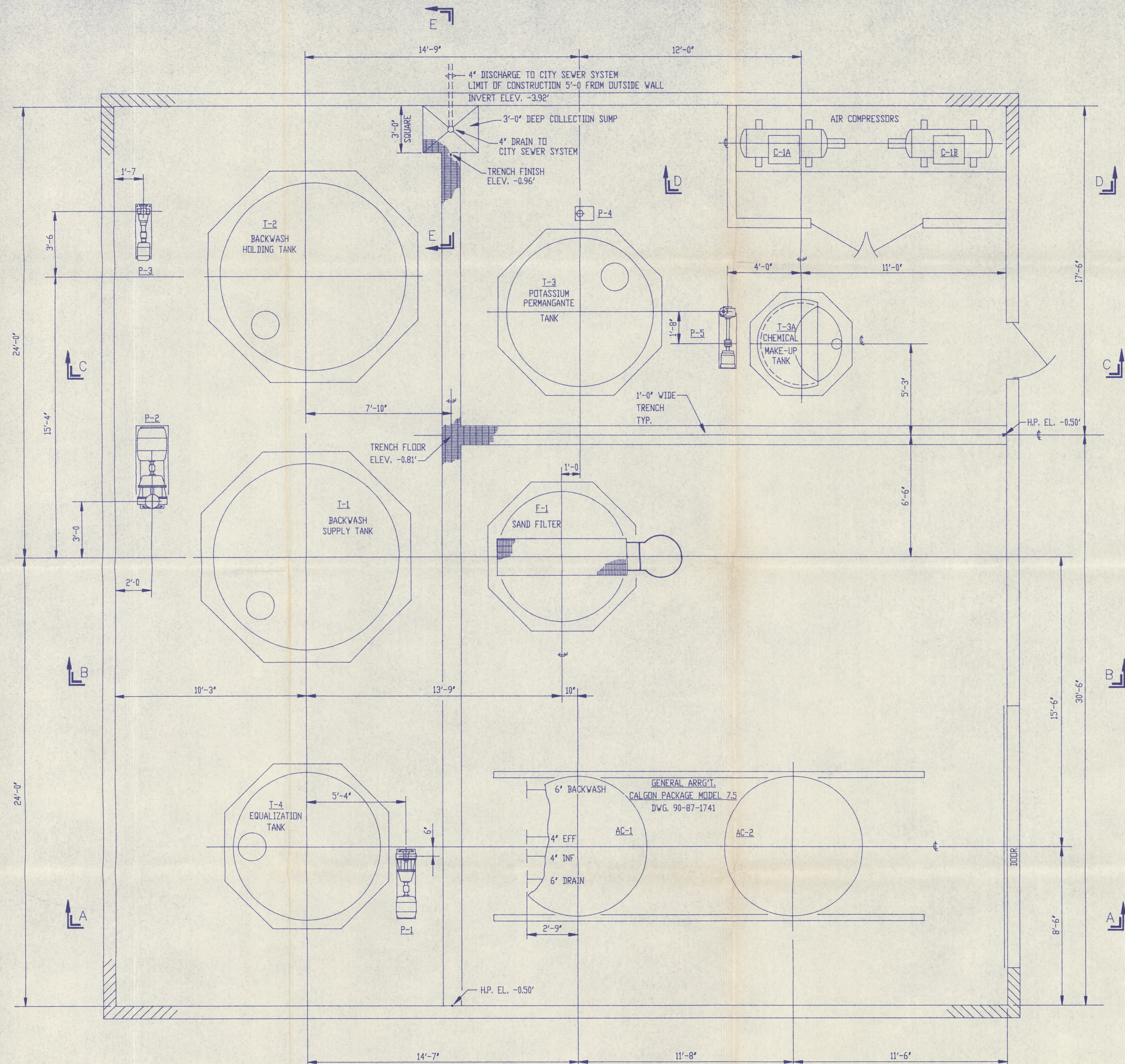
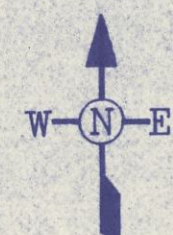


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5145D002 LMENICE 1-22-90
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CALGON CARBON
ACTIVATED CARBON PACKAGE
(SKID MOUNTED)
FOR FLOW DIAGRAM SEE CALGON
DWG. 90-87-1752

REVISION					
1	UPDATED				
2	UPDATED				
3	UPDATED				
4	UPDATED				
5	UPDATED				
6	UPDATED				
DRAWN BY		DATE	CHECKED BY	DATE	SCALE
L. Menice		1-22-90			NONE
P & I D GROUNDWATER TREATMENT ST. LOUIS PARK					DRAWING NUMBER
					352-1002
					REV.
					6

RETEC
REMEDIAL
TECHNOLOGIES, INC.

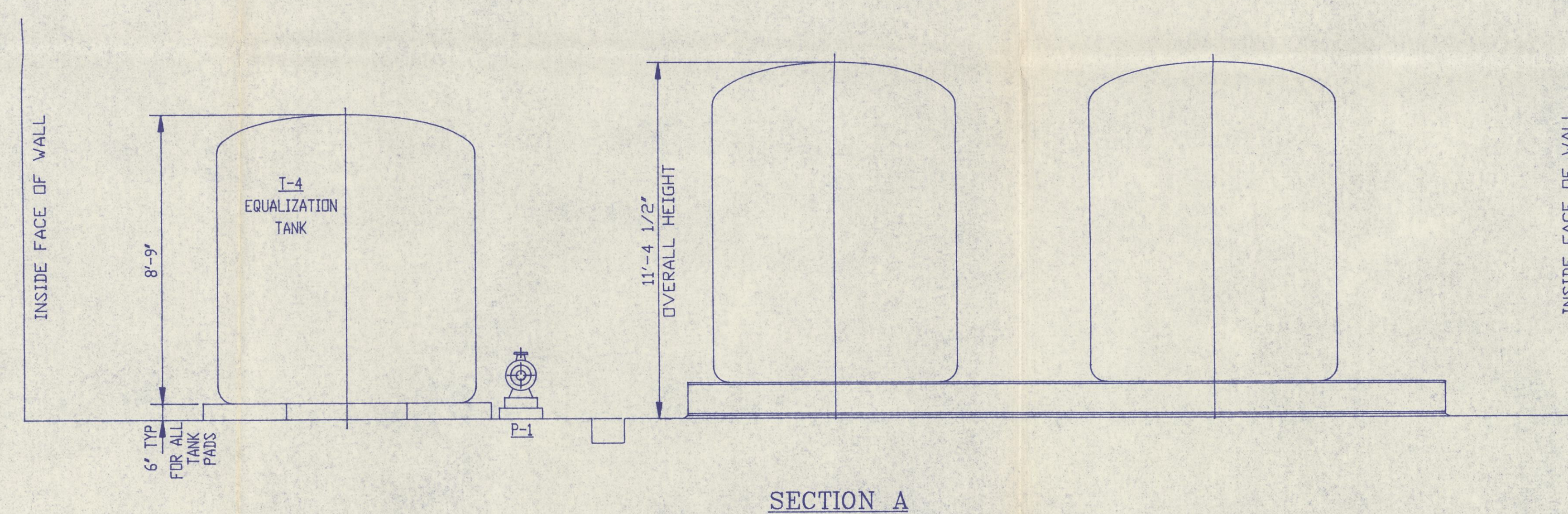
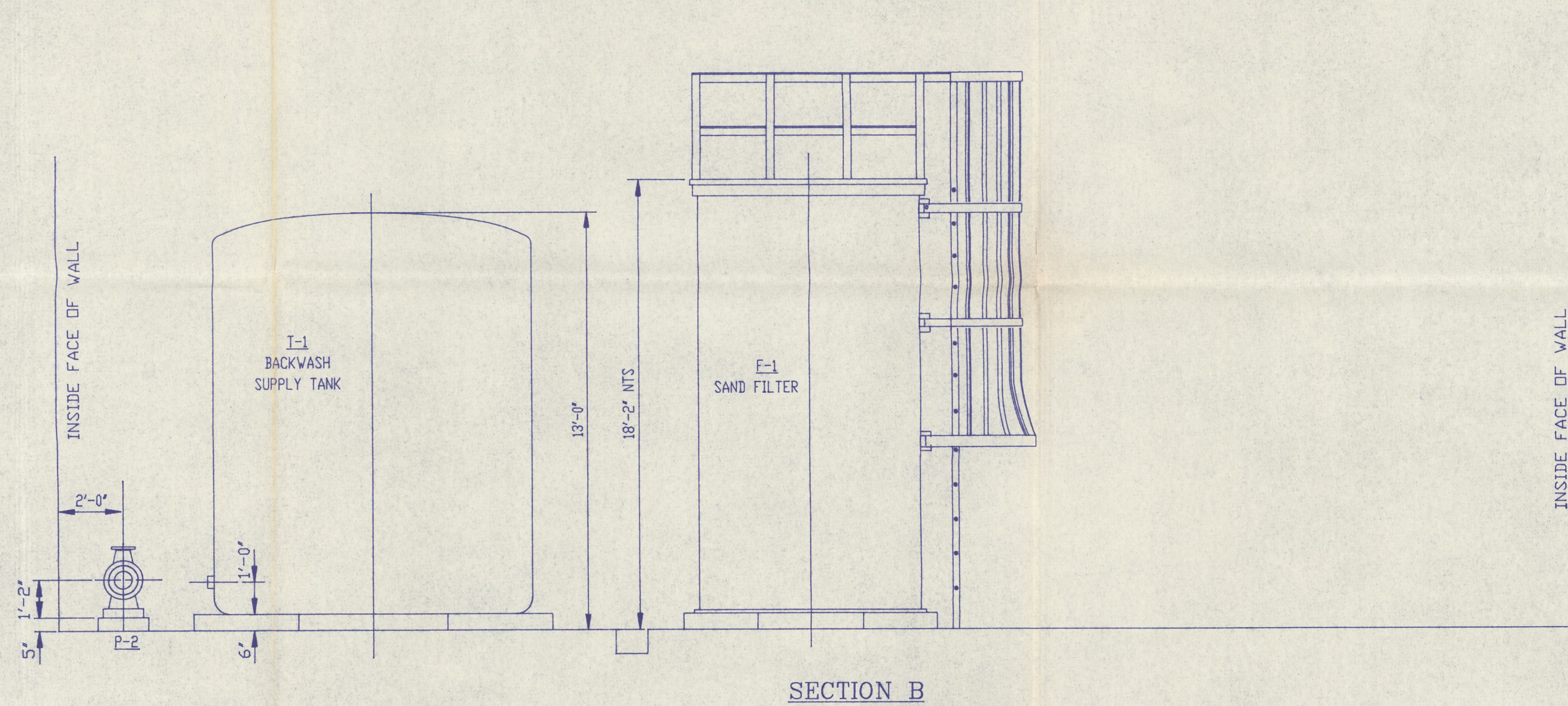
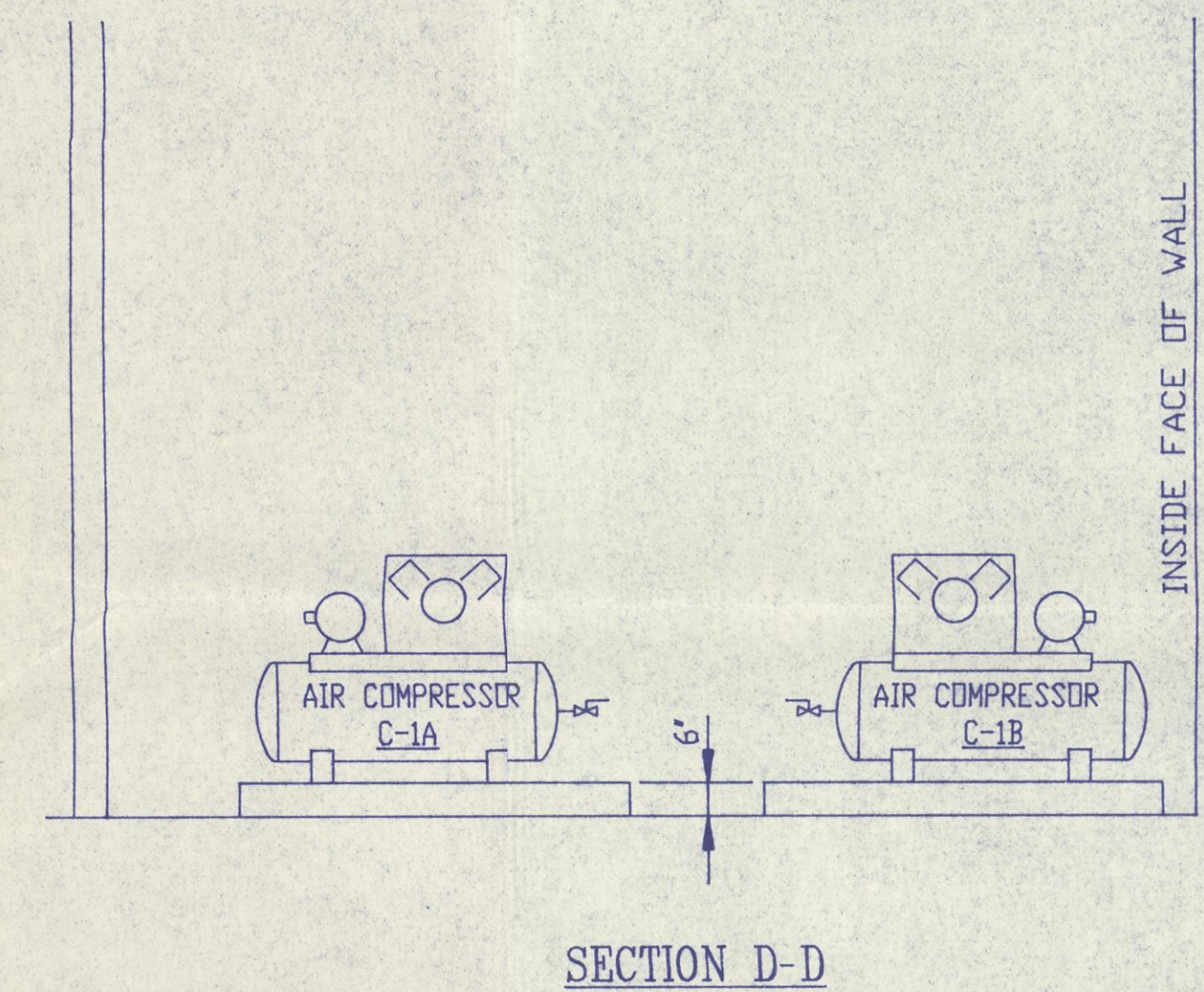
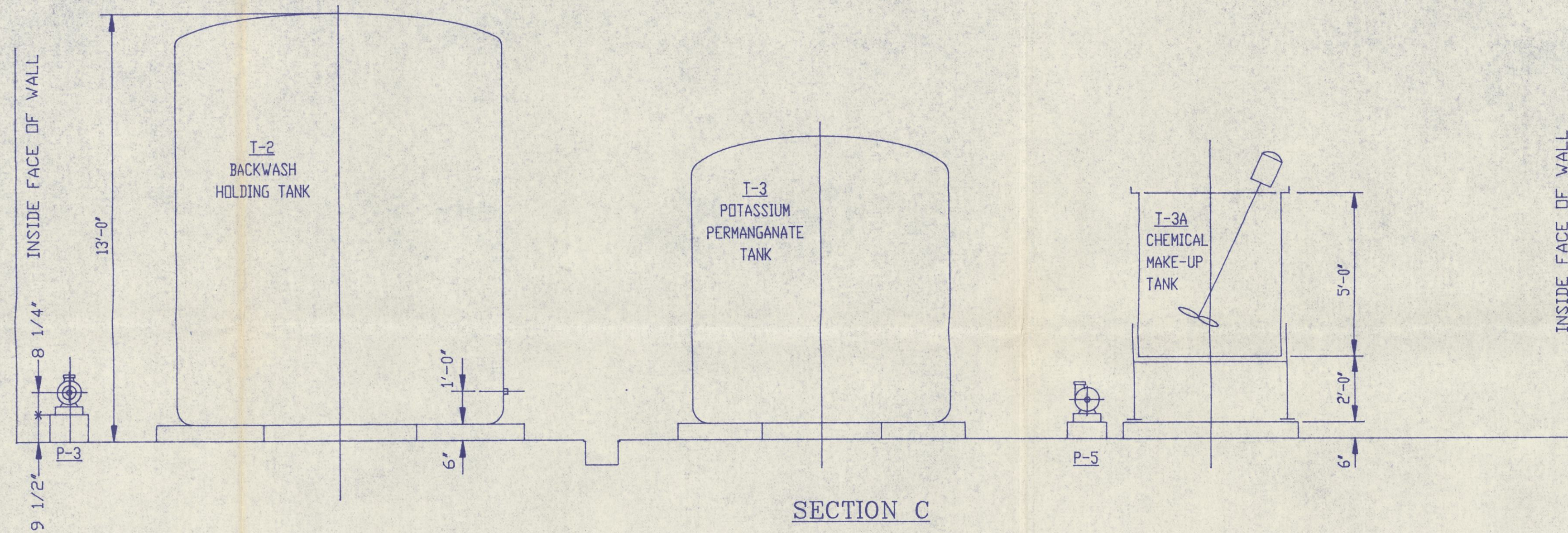


4" DISCH. TO CITY SEWER SYSTEM
INVERT ELEV. -3.92' - LIMIT OF
CONSTRUCTION 5'-0" FROM OUTSIDE
WALL OF STRUCTURE. PROVIDE CAP
FOR FUTURE PIPE CONNECTION.

SECTION E-E
SCALE: 3/4" = 1 FOOT


PLAN
APPROX. INSIDE BUILDING DIM. 48' x 48'

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REVISION									
1	D.T.-CHG.T./LDC.	GENERAL ARRANGEMENT GROUNDWATER TREATMENT ST. LOUIS PARK							
2	GENERAL REV.								
3	GENERAL REV.								
4	GENERAL REV.								
5	RELOCATED EQUIP.								
6	RELOCATED EQUIP.								
7	RELOCATED EQUIP.								
DRWN BY	DATE	CHECKED BY	DATE	SCALE	DRAWING NUMBER	REV.			
R.J.B.	2/22/90			3/8" = 1'-0"	352-1003	7			



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5145G002 M.DILLE 2-28-90
PITTSBURGH, PENNSYLVANIA

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REVISION		ELEVATIONS			 REMEDICATION TECHNOLOGIES INC.		
1	D.T. CHG. T/L DC.	GROUNDWATER TREATMENT ST. LOUIS PARK					
2	GENERAL REV.						
3	GENERAL REV.						
4	GENERAL REV.						
5	RELOCATE EQUIP.						
6	RELOCATE EQUIP.						
7	CHG'D TANK SIZES						
DRAWN BY	DATE	CHECKED BY	DATE	SCALE	DRAWING NUMBER	REV.	
W DILLE	2-28-90	_____	_____	3/8" = 1'-0"	352-1004	7	